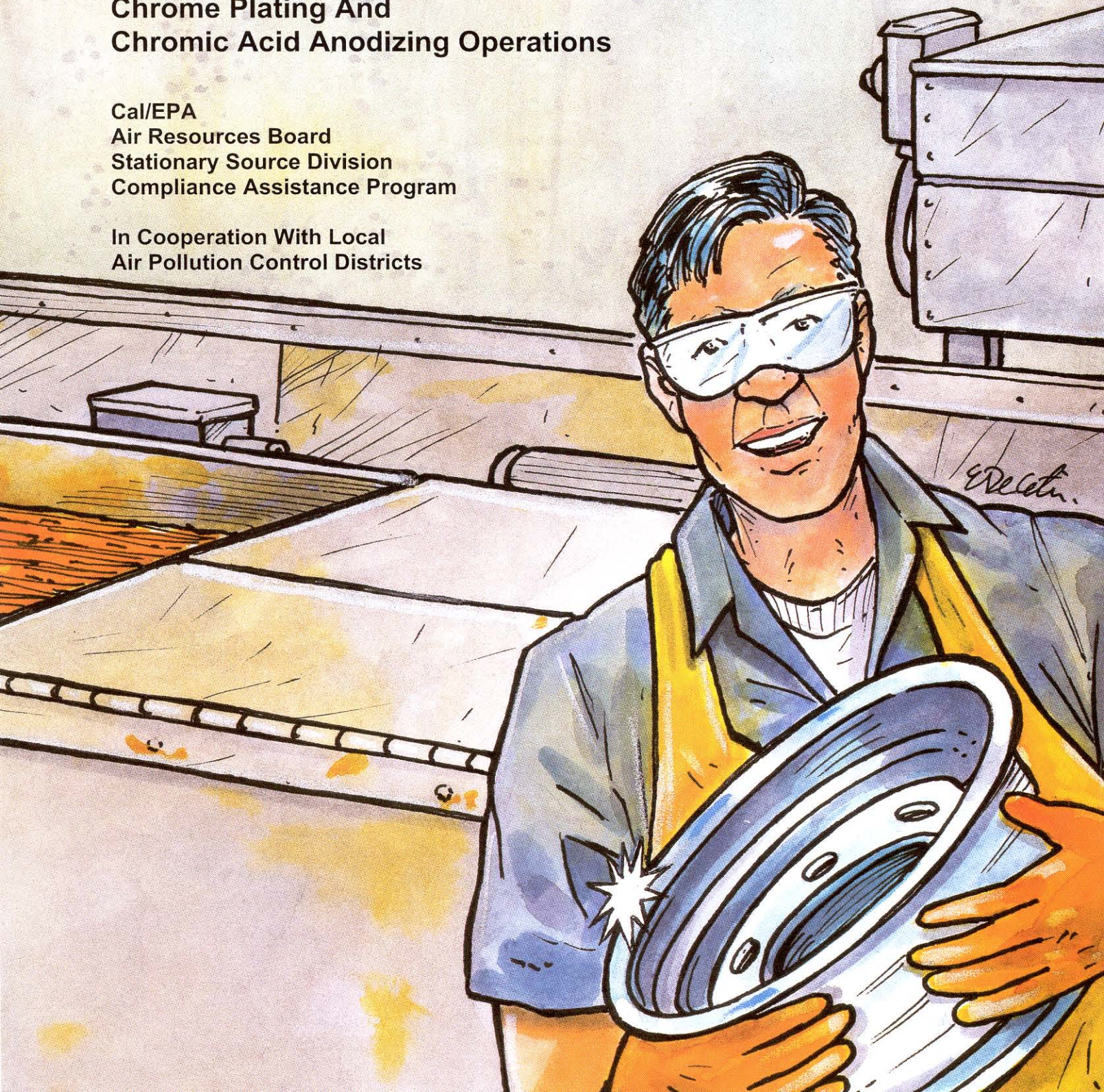
CHROME PLATING AND ANODIZING OPERATIONS

SELF-INSPECTION HANDBOOK

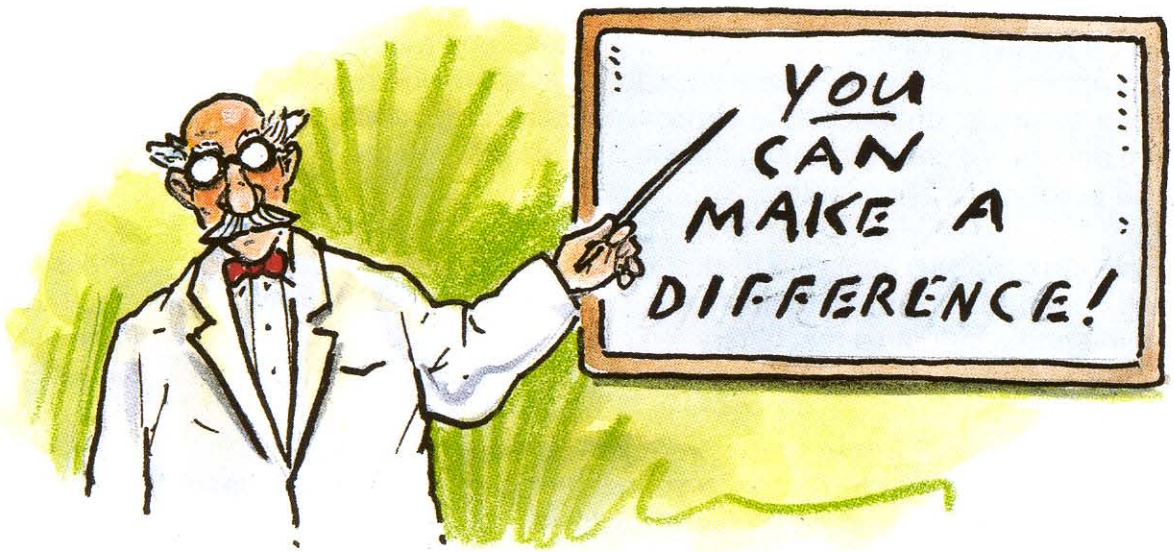
**For Personnel in
Chrome Plating And
Chromic Acid Anodizing Operations**

**Cal/EPA
Air Resources Board
Stationary Source Division
Compliance Assistance Program**

**In Cooperation With Local
Air Pollution Control Districts**



COMPLIANCE ASSISTANCE...



YOU CAN MAKE A DIFFERENCE!

- **REDUCE AIR POLLUTION**
- **IMPROVE WORKING CONDITIONS**
- **IMPROVE THE ENVIRONMENT**

Air pollution increases health care costs and damages property and vegetation. California air pollution control agencies have identified chrome plating and anodizing facilities as one of the many businesses that contribute to air pollution. The purpose of this handbook is to explain why the emissions from chrome plating need to be controlled and how they are controlled. Included in the handbook is a brief discussion of the emission limits and some of the reporting and maintenance requirements for chrome plating facilities. Our intention is that this information will assist owners, supervisors, and environmental managers of chrome plating and chromic acid anodizing facilities by providing an understanding of the air pollution laws and requirements for chrome plating and anodizing facilities. Complying with the law will reduce air pollution and improve working conditions and the environment. **You can make a difference!**

PROCESS

Chrome plating is the electro-deposition of metallic chrome onto a part. Parts are immersed into a heated aqueous solution containing chromium ions through which a direct electric current flows between an anode (positive electrode) and a cathode (negative electrode). The part becomes the cathode (charged cell) in an electroplating solution. The high electric current causes the water molecules in the chromium solution to split into hydrogen and oxygen ions. Bubbles are created at the surface of the tank as the gases emerge from the solution. These bubbles cause a chromic acid ($Cr0_3$) mist to form at the surface of the tank.

There are two types of chrome plating: decorative and hard. **Decorative chrome plating** applies a thin layer of chromium to parts to provide a protective and decorative finish, for example, on faucets, automotive wheels, and bumpers. Less chromium is used in decorative chrome plating than in hard chrome plating. The plating time ranges from 30 seconds to five minutes.

Hard chrome plating applies a thicker layer of chromium in order to put a more durable coating on a part. It is used to apply a thick chromium layer on metal substrates such as engine parts, industrial machinery, and tools to provide greater protection against corrosion and wear. Hard chrome plating time ranges from 20 minutes to 36 hours.

Chromic acid anodizing is an electro-chemical conversion process that creates a wear and corrosion resistant surface on metal objects, but does not result in a metallic chromium layer. However, both chromic acid anodizing and chrome plating generate chromic acid mist.

WHY CONTROL EMISSIONS?

Chromic acid contains hexavalent chromium (Cr^{+6}), which is a toxic air contaminant. This means it is an air pollutant that may cause or contribute to an increase in deaths or in serious illness, or pose a present or potential hazard to human health. Most chrome plating facilities use Cr^{+6}, although trivalent chromium (Cr^{+3}) may also be used in decorative chrome plating. Although Cr^{+3} has a lower toxicity than Cr^{+6}, both are hazardous materials. Airborne mists containing chromic acid or Cr^{+6} may be inhaled or come in contact with the skin. Therefore, it is important that these mists be controlled. It is important to know that the lower the efficiency of the plating operation, the greater the amount of acid mist formed.

Hexavalent chromium is the most toxic form of chromium and is a known human carcinogen. Hexavalent chromium can enter the body when people breathe air, eat food, or drink water containing it. It may also be found in house dust and soil that can be ingested or inhaled. There is a wide range of health effects from exposure to Cr^{+6}. Long term (chronic) effects from inhaling high concentrations may cause a runny nose, sneezing, skin rashes, nosebleeds, ulcers, holes in the nasal septum, and lung cancer. Short term (acute) effects may cause kidney damage, nausea, irritation of the gastrointestinal tract, stomach ulcers, and convulsions.

HEALTH EFFECTS OF Cr^{+6} TOXIC EMISSIONS

<u>ACUTE</u> (Short Term)
KIDNEY DAMAGE
STOMACH PROBLEMS

<u>CHRONIC</u> (Long Term)
RESPIRATORY DAMAGE
LUNG CANCER
SKIN RASHES
DAMAGE TO MUCOUS MEMBRANES
AND NASAL PASSAGES

PROTECT YOURSELF!!!

Electroplating is a wet chemical operation. Splashes from plating or rinse tanks, and spills of plating solution may contact skin or clothing and create a potential health hazard.

<u>Be sure</u> to watch for deterioration of electrical systems in corrosive and wet environments.

<u>AVOID</u>

SPLASHES PUDDLES SPILLS

SPARKS OR FLAMES

<u>WEAR</u>

SAFETY GLASSES AND PROTECTIVE CLOTHING

FUME SUPPRESSANTS AND CONTROL EQUIPMENT

Hexavalent chromium compounds may become airborne as fine dust particles that eventually settle over the land and water. Fume suppressants and control equipment are needed to limit the emissions of these particles.

FUME SUPPRESSANTS

Chemical fume suppressants are chemicals that reduce or suppress fumes or mists at the surfaces of chrome plating or anodizing tanks. Chemical fume suppressants containing wetting agents reduce the surface tension of a plating bath, thereby reducing the emissions of chromic acid mist from the tank. With Cr^{+6}, the fume suppressant is usually added separately to the plating bath.

Some fume suppressants can also reduce emissions by creating a foam blanket on top of the plating solution. Foam blankets provide an effective control if they are kept at a proper thickness. They retard the release of hydrogen from the plating tank surface. This process may create the risk of an explosion due to the buildup of hydrogen gas in the tank. It is important to make sure that caution be taken to prevent any type of ignition (spark or flame) around a foam blanket or a bath surface. The explosion risk is greater with the use of foam blankets than with wetting agents.

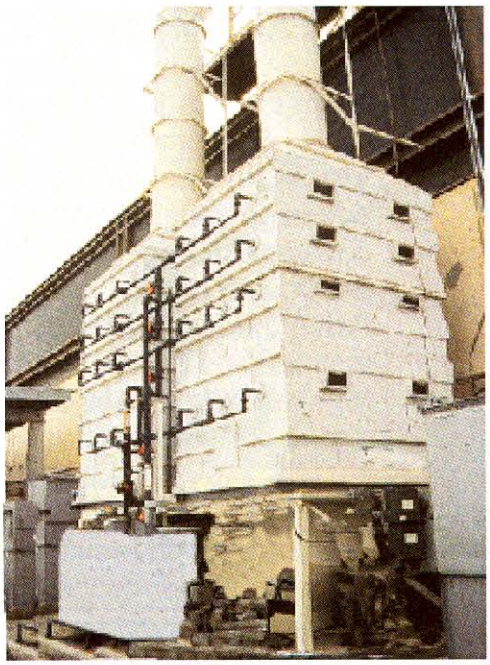
Mechanical fume suppressants reduce fumes or mists at the surfaces of chrome plating or anodizing tanks by direct contact with the surface of the bath. Polyballs and polypropylene tubes are mechanical fume suppressants that float on the surface of a plating solution to control fumes.

CONTROL EQUIPMENT

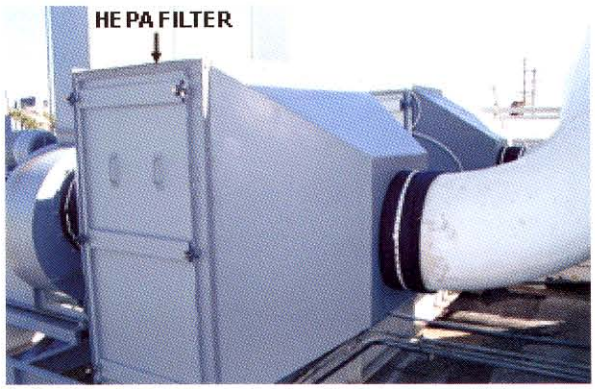
Add-On Controls are air pollution control equipment installed in the ventilation system of chrome plating and anodizing tanks to collect and contain chromium emissions. Plating tanks with add-on controls have a forced ventilation system designed to remove the chromic acid mist. Exhaust hoods or vents are commonly situated along the sides of the tank surface. The exhaust hoods pull the air from the surface of the tank to the add-on control(s). For exhaust hoods or other tank ventilation systems to work efficiently, they must be properly designed and maintained. Drafts of air from open windows, doors, and floor fans must be reduced as they can limit the ability of the exhaust hoods to draw off the chromic acid mist.

Add-on control devices such as packed-bed scrubbers (PBS), composite mesh pad (CMP) systems, PBS/CMP systems, fiber-bed mist eliminators, and high efficiency particulate arrester (HEPA) filters control the chromium emissions after they have been collected in a duct and conveyed to the control device. Some of these control devices are shown below:

Fiber-Bed Mist Eliminator



Composite Mesh Pad (CMP)



During tank operation, control equipment is closely monitored and must meet specific emission and maintenance requirements. The pressure drop across all units and ducts of control equipment should be monitored daily.

Every facility with an add-on control device must prepare an operation and maintenance (O&M) plan specific to their operation. This O&M plan must be available for inspection upon request and revised as necessary to minimize breakdowns.

The table below summarizes inspection and maintenance requirements:

EQUIPMENT INSPECTION AND MAINTENANCE SCHEDULE

Control Technique/Equipment	Inspection & Maintenance Requirements	Frequency
Polyballs Polypropylene tubes	Visually inspect tank for coverage consistent with coverage during performance test.	Daily
Foam blanket	Foam thickness shall be maintained consistent with requirements established during performance test.	Measured hourly for 15 days and daily thereafter as long as consistent with thickness requirement.
Chemical fume suppressant containing a wetting agent	Surface tension resulting in $\leq$ 45 dynes per centimeter.	Once a week
*PBS, CMP, PBS/CMP, Fiber-bed mist eliminator	1. Visually inspect for proper drainage. 2. Check for unusual chromic acid buildup. 3. Check for leaks in duct work, mesh, or fiber. 4. Wash down composite mist pads and fiber elements. 5.Visually inspect back of chevron blade mist eliminator for chromic acid mist. 6. Add fresh water to packed-bed.	1. Quarterly 2. Quarterly 3. Quarterly 4. Per manufacturer 5. Quarterly 6. As needed
HEPA filter	1. Look for changes in pressure drop. 2. Replace HEPA filter.	1. Once a week 2. Per manufacturer or permit requirements

***Inspection & maintenance requirements are to be done separately for each control technique/equipment**

EQUIPMENT INSPECTION AND MAINTENANCE SCHEDULE (Cont'd)

Control Technique/Equipment	Inspection & Maintenance Requirements	Frequency
Chrome Tank Covers	1. Drain air-inlet (purge air) valves.	1. Daily (when tank is in operation)
	2. Visually inspect access door seals and membranes.	2. Once a week
	3. Drain evacuation unit directly into plating or rise tank.	3. Once a week
	4. Visually inspect membranes for perforations.	4. Once a month
	5. Visually inspect all clamps for proper operation.	5. Once a month
	6. Clean or replace filters on evacuation unit.	6. Once a month
	7. Visually inspect piping connected to evacuation unit.	7. Quarterly
	8. Replace access door seals, membrane evacuation unit filter, and purge air inlet check valves.	8. Per manufacturer

EMISSION STANDARDS

The emission standards for chrome plating and chromic acid anodizing operations are listed in Section (c) of the **Hexavalent Chromium Airborne Toxic Control Measure (ATCM) for Chrome Plating And Chromic Acid Anodizing Operations (ARB 1998)**.

Any existing, modified, or new **hard chrome plating operation** must control hexavalent chromium emissions discharged to the atmosphere from that source by reducing the emissions using add-on air pollution control devices. Small hard plating operations existing on or before December 16, 1993, using less than or equal to 500,000 ampere-hours per year (≤ 500,000 amp-hr/yr), may not be subject to the emission standards listed in the ATCM. The air district or permitting agency may approve on a case-by-case basis alternative standards for these operations. At a minimum the source must use a chemical fume suppressant containing a wetting agent to lower the surface tension of the plating tank to at least 45 dynes per centimeter.

The emission standards for hard chrome plating are shown in the following tables:

Hard Chrome Plating Operations (on or before 12/16/93)

Hard Chrome		Requirement		
Facility Size	Controlled Emissions [1] (lb/yr)	≤60 million amp-hrs [2]	>60 million amp-hrs [2]	
			Option 1	Option 2 [3]
Large	≥10 lbs/yr	≤0.006 mg/amp-hr	≤0.006 mg/amp-hr	≤0.006 mg/amp-hr
Medium	<10 lbs/yr but >2 lbs/yr	≤0.03 mg/amp-hr	≤0.006 mg/amp-hr	≤0.03 mg/amp-hr and 0.015 mg/dscm
Small	≤2 lbs/yr	≤0.15 mg/amp-hr	≤0.03 mg/amp-hr	≤0.15mg/amp-hr and 0.015 mg/dscm

Hard Chrome Plating Operations (New/ Modified Operations After 12/16/93)

Hard Chrome		Requirement	
Facility Size	Controlled Emissions [1] (lb/yr)	≤60 million amp- hrs [2]	>60 million amp-hrs [2]
Large	≥10 lbs/yr	≤0.006 mg/amp-hr	≤0.006 mg/amp-hr
Medium /Small	< 10 lbs/yr	≤0.03 mg/amp-hr	≤0.006 mg/amp-hr

[1] Combined hexavalent or total chrome emissions from hard chrome plating operations
[2] Maximum cumulative potential rectifier capacity or usage limit
[3] "Option 2" is an alternative emission limitation for small and medium facilities that elect to demonstrate compliance with both a mg/amp-hr and a mg/dscm requirement

Any existing, modified, or new **decorative chrome plating operation** must also control hexavalent chromium emissions. Source tests must be performed to determine emission rates when add-on controls, chemical, or mechanical fume suppressants are used to demonstrate compliance with the standard less than or equal to 0.01 milligrams per dry standard cubic meter of air (≤ 0.01 mg/dscm). Facilities using chemical fume suppressants containing wetting agents must lower the surface tension of the plating tank to less than or equal to 45 dynes per centimeter (≤ 45 dynes/cm).

The emission standards for decorative chrome plating and acid anodizing facilities are shown in the table below (Also included in the table are the emission standards for decorative chrome plating tanks using a trivalent chromium bath):

Decorative Chrome Plating and Chromic Acid Anodizing Facilities

Method of Compliance	Requirement
Add-on air pollution control equipment, or chemical fume suppressants, or mechanical fume suppressants (i.e. polyballs)	*≤0.01milligrams per dry standard cubic meter of air (mg/dscm) ($4.4x10^{-6}$ gr/dscf)
Chemical fume suppressants containing a wetting agent	**≤ 45 dynes per centimeter (dynes/cm) ($3x10^{-3}$ pound-force per foot [lbF/ft])

*Same requirement for Trivalent Chromium Bath
** For Trivalent Chromium Bath: Use wetting agent as bath ingredient and comply with recordkeeping and reporting provisions of the Hexavalent Chromium ATCM for Chrome Plating And Chromic Acid Anodizing Operations.

REDUCE EMISSIONS

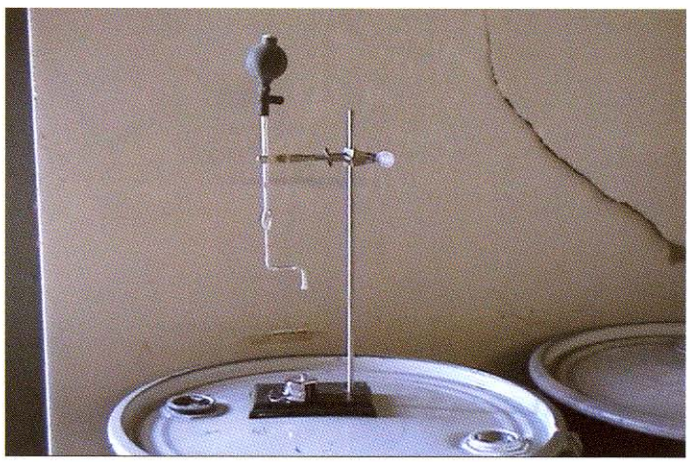
"FOLLOW THE LAW"

PARAMETER MONITORING

The following gauges and meters must be maintained and monitored by facility operators:

TOTALIZER

A totalizer measures the total amount of electrical current (amperes) applied to a plating tank over a period of time (hours), expressed as ampere-hours (amp-hrs).

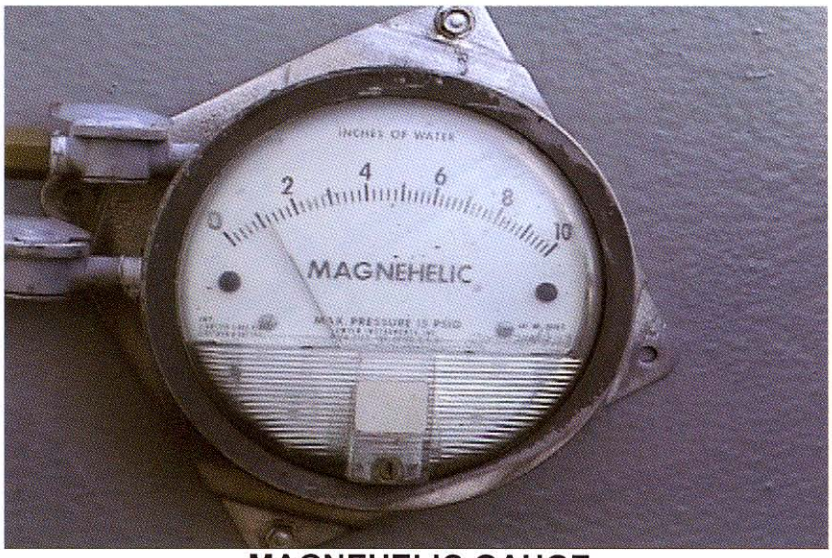


STALAGMOMETER

A stalagmometer is commonly used to measure the surface tension of the chromium bath, expressed as dynes per centimeter (dynes/cm).

REDUCE EMISSIONS

"FOLLOW THE LAW"



MAGNEHELIC GAUGE

A magnehelic gauge measures the pressure drop across the filter, expressed as inches of water. Manometers and pitot tubes may also be used to measure pressure drop.

Don't Forget the Monitoring Requirements!!!

Meter/Gauge	Measures	Monitoring Requirements
*Totalizer	Total amount of electrical current in ampere-hours.	Continuous recording, non-resettable, ampere-hour meter with a separate meter hard-wired for each rectifier.
*Stalagmometer/ Tensiometer	Surface tension in dynes per centimeter.	Measured daily for 20 operating days and weekly thereafter if no violation.
*Magnehelic Gauge Manometer Pitot tube	Pressure drop measured in inches of water (shall be continuously monitored across add-on control device).	Must be visible and in clear sight. Pressure drop maintained within ± 1 inch of water of **PTV to demonstrate compliance with emission limits for CMP, PBS, CMP/PBS, and fiber-bed mist eliminator and within 1/2 times to +2 times the inches of water of PTV to demonstrate compliance with emission limits for HEPA filters.

*All meters and gauges should be inspected and maintained as per manufacturers' specifications. Specifications shall be available on site unless an outside laboratory is conducting testing.

**PTV = performance test value

REMEMBER TO KEEP ACCURATE RECORDS

RECORDKEEPING

Inspection records must be maintained for: add-on control devices, chemical and mechanical fume suppressants, performance tests, monitoring data, breakdowns, exceedances of emission limits, demonstrating facility size, fume suppressant additions, trivalent bath components, and new/modified source review information. Records must be kept for five years. The last two years of records must be kept on site.

Check with your local air district for specific recordkeeping requirements and forms!

Don't Forget the Reports!!!!

1. ***Performance Tests*** ✓
2. ***Initial Compliance Status Report*** ✓
3. ***Ongoing Compliance Status Reports*** ✓
4. ***Reports of Breakdowns*** ✓
5. ***Reports Associated with Trivalent Chromium Baths*** ✓
6. ***Adjustments To Timeline For Submittal/Format Of Reports*** ✓

ATTENTION: POLLUTION AFFECTS MULTI MEDIA:

Inspections should be coordinated with inspectors from different agencies to form multi media teams to:

NOTES:

NOTES:

Need More Information?

Air Resources Board (800) 952-5588 **District: _____**

Multi-County Districts

1 - Bay Area (415) 749-5000
2 - Feather River (530) 634-7659
3 - Great Basin (760) 872-8211
4 - Monterey Bay (831) 647-9411
5 - North Coast (707) 443-3093
6 - Northern Sierra (530) 274-9360
7 - South Coast (909) 396-2000
8 - Yolo-Solano (530) 757-3650
9 - San Joaquin Valley (559) 230-6000

County Districts

Amador (209) 257-0112
Antelope Valley (661) 723-8070
Butte (530) 891-2882
Calaveras (209) 754-6504
Colusa (530) 458-0590
El Dorado (530) 621-6662
Glenn (530) 934-6500
Imperial (760) 482-4606
Kern (661) 862-5250
Lake (707) 263-7000
Lassen (530) 251-8110
Mariposa (209) 966-2220
Mendocino (707) 463-4354
Modoc (530) 233-6419
Mojave Desert (760) 245-1661
No. Sonoma (707) 433-5911
Placer (530) 889-7130
Sacramento (916) 874-4800
San Diego (858) 650-4700
San Luis Obispo (805) 781-4247
Santa Barbara (805) 961-8800
Shasta (530) 225-5789
Siskiyou (530) 841-4029
Tehama (530) 527-3717
Tuolumne (209) 533-5693
Ventura (805) 645-1400

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California Environmental Protection Agency
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